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A Situation Report - Iowa State's "Closed" Dairy Herd

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Iowa State's "Closed" Dairy Herd

A Holstein herd at Iowa State has been closed to outside blood for about 30 years. Here are some developments to date regarding the effects of selection and the results of mild inbreeding that occurred in the herd.

by A. E. Freeman

HOW DOES mild inbreeding affect a dairy herd? Also, how effective is selection in a "closed" herd?

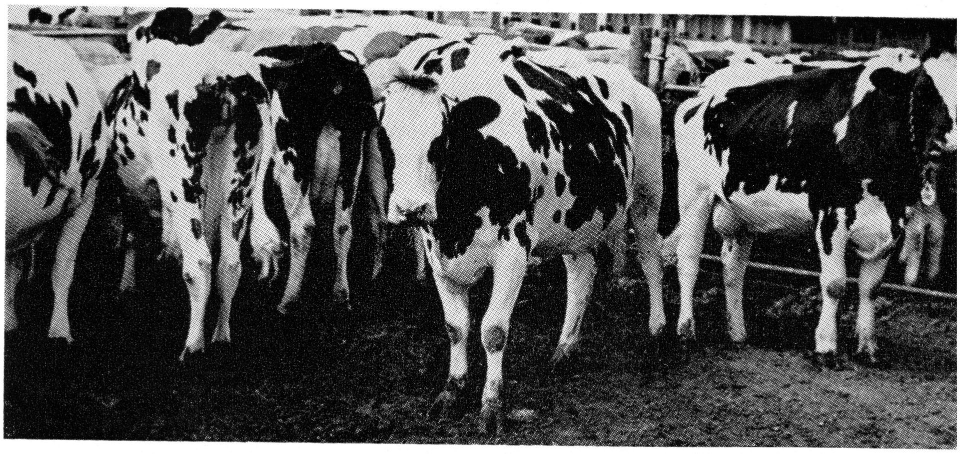
The Holstein herd at Iowa State has been used to help answer these and other questions. For the most part, the herd has been closed to outside breeding since 1934 — completely so since 1937. The herd was closed to outside blood so that the effects of selection and of inbreeding could be measured more accurately than if animals from other herds had been introduced into the herd. If animals from other herds had been introduced, the true breeding values of these animals might have been higher or lower than they were thought to be. These values could have been confused with the effects of the items being studied.

Selecting breeding animals only from within the closed herd resulted in mild inbreeding. The cattle weren't purposely inbred. But, since no animals were brought into the herd, the cows and bulls gradually became more closely related.

With mild inbreeding, the relationship between cows and bulls ordinarily increases slowly. But the relationship can intensify sharply; for example, if a cow is thought so good and lives so long that several of her sons are used for breeding one after the other.

Breeding Plan . . .

The breeding plan was to use



the best available son of the best producing cow long enough so that at least eight of his daughters would freshen into the herd. On the average, each sire was used for slightly more than a year, then sold. Two bulls of breeding age were kept at any one time. This was partly to insure that, in case of an accident to one bull, the other bull would be available for service. Also, an older bull was retained until a younger bull, to be used next, was sound for breeding.

As far as possible, all first-calf heifers were kept for at least 8 months of their first lactation. This practice gave each heifer an opportunity to produce to her capability during her first lactation. It also permitted accurate production records by avoiding mistakes in cases where some heifers produced at low levels initially but were persistent producers.

Data from the Iowa State herd and from others indicate that, in a commercial herd, it isn't necessary to keep all heifers for as long as 8 months before culling. Keeping heifers for at least 8 months, however, still seems a sound practice in an experimental herd where accuracy of the production data has both scientific and commercial value. The first 3 to 5 months of lactation usually indicate a cow's potential producing ability accurately enough so that low-producing, first-calf heifers can be culled after that time. But it usually isn't good business to cull a cow until she passes the peak of her lactation.

Selection: Since 1941, cows kept in the herd have been selected on the basis of an index. The selection index is based on the records of the cow, her dam, her daughters, her maternal sisters and her paternal sisters. This index weights the records on each group of animals according to the number of records each cow has and according to the relationship of that group of animals to the cow being considered for keeping or culling.

Production is considered about three times as important as type in the index. In practice, this means that the major selection decisions are based on production. Differences in type, however, may change decisions that would be moderately close on production alone.

The production records for the

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first 243 days of each lactation (instead of the usual 305 days) were used for making selections. Thus, no corrections were needed for differences in the length of time after calving that a cow again became pregnant.

Results: From 1930 to 1958, 685 cows in the herd made 1,747 records. These data indicate that the genetic worth of the herd increased at a rate of 0.6 to 1.0 percent of the herd average per year. Based on current production, this is an average increase in genetic worth of 3.5 to 5.9 pounds of butterfat per cow per year.

The May 1962 actual DHIA 12-month rolling average for the herd was 15,290 pounds of milk and 541 pounds of butterfat. On a mature-equivalent, 305-day lactation basis, this is about 16,800 pounds of milk and 595 pounds of butterfat. Production in 1930 was 11,835 pounds of milk and 358 pounds of fat on a mature-equivalent, 305-day basis. This increase in production resulted from both genetic gains and improvements in feeding and management.

Genetic Gain in dairy cattle through selection for increased production is slow because of limited culling of low-producing cows and the long generation interval; that is, the average age of parents when their first offspring are born.

In any closed population, an improvement in genetic gain of about 1 percent of the herd average per year is near the theoretical limit with natural service. Results with the Iowa State herd agree with this. Though genetic gain is slow, it accumulates as selection continues. Since each generation depends on the previous generation, the cumulative effects of genetic gain can become large over a period of many years.

Artificial insemination could cause more rapid genetic gains than natural service. This is because artificial insemination permits more intensive selection of bulls. Exactly how much the use of artificial insemination could increase the rate of genetic gain isn't certain, but a rate of as much as 1½ times faster than natural service seems definitely possible.

In the Iowa State herd, most of the genetic gain was made by saving sires from the best cows. Dams of sires were about 7 percent genetically superior to their herd mates.

Using progeny-tested sires isn't practical in an experimental herd of the size at Iowa State. Besides the expense of keeping the bulls to about 6 years of age—when they would first be proved, and then discarding those with the poorest proof—using progeny-tested sires would increase the generation interval. This, in turn, would tend to reduce genetic gain per year, even though gain per generation might increase.

Some selection was possible among the sires of the young bulls saved for use. This was done by using more extensively the young bulls whose sires seemed better as their daughters began to freshen or as other bits of the young bulls' pedigree information improved. The sires of the bulls used were 1.37 percent genetically superior to all sires produced in the herd. Cows with daughters that freshened in the herd averaged 1.24 percent superior genetically to their herd mates.

Inbreeding: Inbreeding in the herd ranged from 0 to 35 percent. All cows calving in 1958 averaged 13.3-percent inbred. This 13.3 percent, accumulated during more than 20 years, is only slightly more inbreeding than would be present in the offspring of a single half brother-half sister mating.

Production fell an average of 1.74 pounds of butterfat and 54 pounds of milk for each 1-percent increase in inbreeding. This small decline in production, as inbreeding progressed, agrees fairly well with the findings of other research.

A small reduction in body size, particularly at immature ages, also accompanied inbreeding. Body weight of the animals averaged about 7 pounds less at 3 years of age for each 1-percent increase in inbreeding. As the animals approached maturity, however, the inbreds tended to catch up in size with the other animals. Inbreeding appeared to slow the animals' growth rate but had little effect on their ultimate mature size.

The tendency for production and growth to decline as inbreeding became more intense is a general decrease of many different, but small effects. Major genetic effects weren't particularly apparent in specific individuals. This suggests that the harmful effects of inbreeding cannot be completely controlled by selecting against them, though such selection would help. No malformed or dead calves have been born into the herd as a result of genetic causes. But if genes that cause major malformations had been frequent in the herd when it was closed to outside blood, inbreeding could have been expected to make some of these genes more abundant and others more scarce.

Future Plans . . .

The breeding plan of the Holstein herd has been modified recently to measure directly whether the herd has become different—and, if so, how much—from the rest of the breed. Two-thirds of the herd is being continued as a closed herd. The other cows and their descendants are being bred to bulls that are used for artificial breeding and in the Iowa Board of Control herds. Also, some of the sires in the closed herd are being used in the Board of Control sampling program.

This system will give reciprocal-cross information from linebred and outbred cattle. Ultimately, the outbreds will become practically unrelated to their stablemates in the closed part of the University herd. The information also should help answer the question: How much, if any, heterosis ("hybrid vigor" or superiority of crosses over average of parents) results from crossing linebred and unrelated dairy cattle?

The first of the outbred calves was born in March 1961, so it will be several years before we have enough information to help answer that question. Meanwhile, the herd continues to yield information on many topics such as selection indexes, consequences of selection and the effects of mild inbreeding.